

Design Considerations for Terracotta Rainscreen Systems

NBKRSC1

Thursday, June 21, 2018; 2:15 PM to 3:15 PM

1.00 LU

This presentation is protected by U.S. and international copyright laws.

Reproduction, distribution, display and use of the presentation without written permission of the speaker is prohibited.

This program is registered with the AIA/CES for continuing professional education. As such, it does not include content that may be deemed or construed to constitute approval, sponsorship or endorsement by AIA of any method, product, service, enterprise or organization.

The statements expressed by speakers, panelists, and other participants reflect their own views and do not necessarily reflect the views or positions of The American Institute of Architects, or of AIA components, or those of their respective officers, directors, members, employees, or other organizations, groups or individuals associated with them.

Questions related to specific products and services may be addressed at the conclusion of this presentation.

Speakers List

- Bud Streff
Director of Sales
NBK North America
- Mike Cleere
Director of Façade Engineering
NBK North America

Course / Learning Objectives

- Understanding the concept of the Rainscreen Principle for moisture control and differentiate between the two (2) types of rainscreen implementations.
- Identify the main components of a Rainscreen façade system, and their roles in the building envelope.
- Describe the six (6) main processes in manufacturing terracotta façade panels.
- Explain the aesthetics of terracotta, like – color and texture, and how it affects the appearance of a building exterior.

- **Rainscreen**

 - Understanding the Rainscreen Principle

- **Terracotta**

 - The Value of Terracotta as a Rainscreen Cladding

- **Design Options**

 - Design Considerations of Terracotta Rainscreen Façade

- **Façade Application**

 - Overview of Façade Types – Stick-Built, Panelized, Unitized, and Façade Refurbishment Case Study

Rainscreen Principle

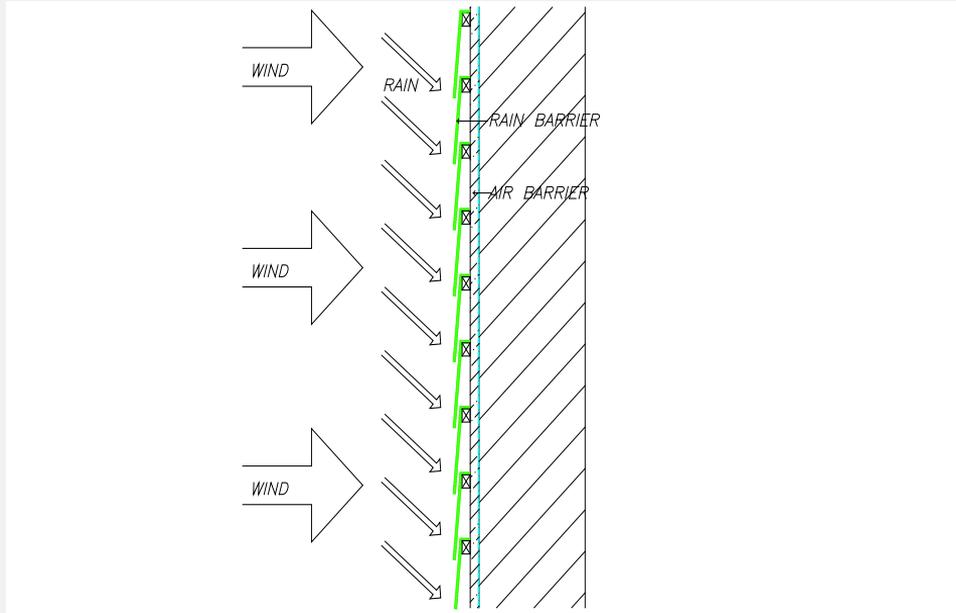


Figure 1 Traditional tile hung wall.

- Rainscreen is a Two-stage wall and has been used for many years dating back to the 1940's.
- A good example is the traditional “tile” or wood clad wall.
- The Outer layer is the Rainscreen and the Inner layer is your air barrier, separated by an air cavity.

Two Rainscreen Types

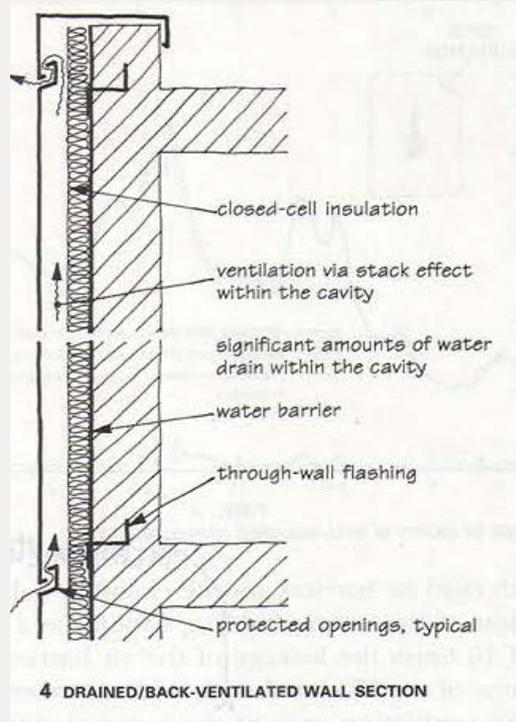
Drained and Back-Ventilated



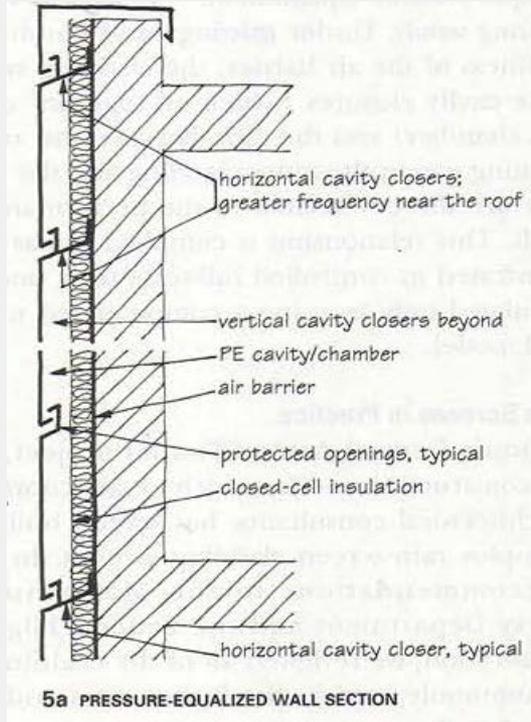
Pressure-Equalized
Compartmentalized (use of cavity closures)



Drained and Back-Ventilated (Chimney Effect)

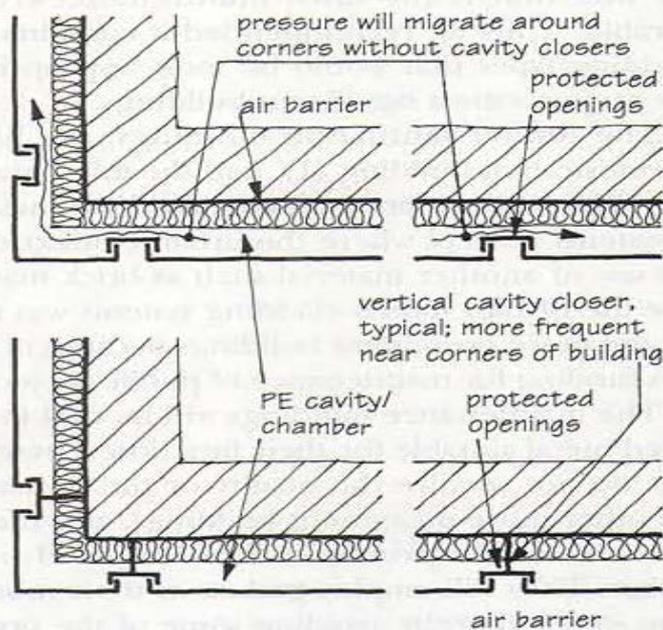


Pressure-Equalized Compartmentalized (Cavity Closures)



- Air-barrier (membrane)
- Insulation (closed cell or semi-rigid)
- Air cavity (stack effect) – never trapping moisture
- Protected Opening (panel to panel or tile to tile joints)

Rainscreen



5b PRESSURE-EQUALIZED WALL PLANS

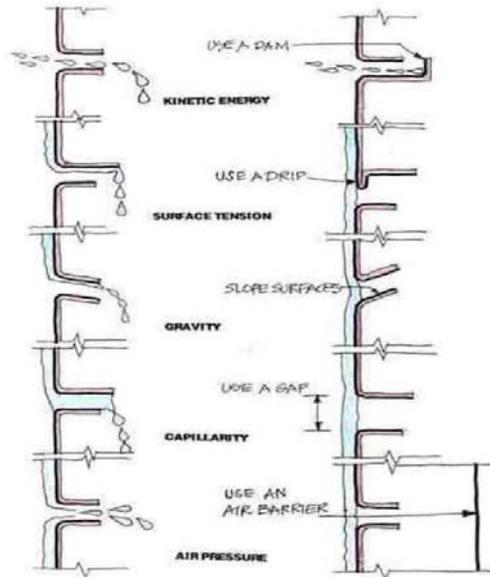
Figure 4. Richard Keleher. AIA

Corner Condition (+/- Pressure)

- In a Drained and Back-Ventilated Rainscreen, when you have a pressure differential (+/- Pressure), the water will migrate.
- In a Pressure-equalized Rainscreen, the vertical cavity closures create chambers, equalizing the pressure.

Moisture “control issues” result from multiple forces driving water into buildings

Rain Forces Diagram



©Richard Keteher

Forces acting on our walls include:

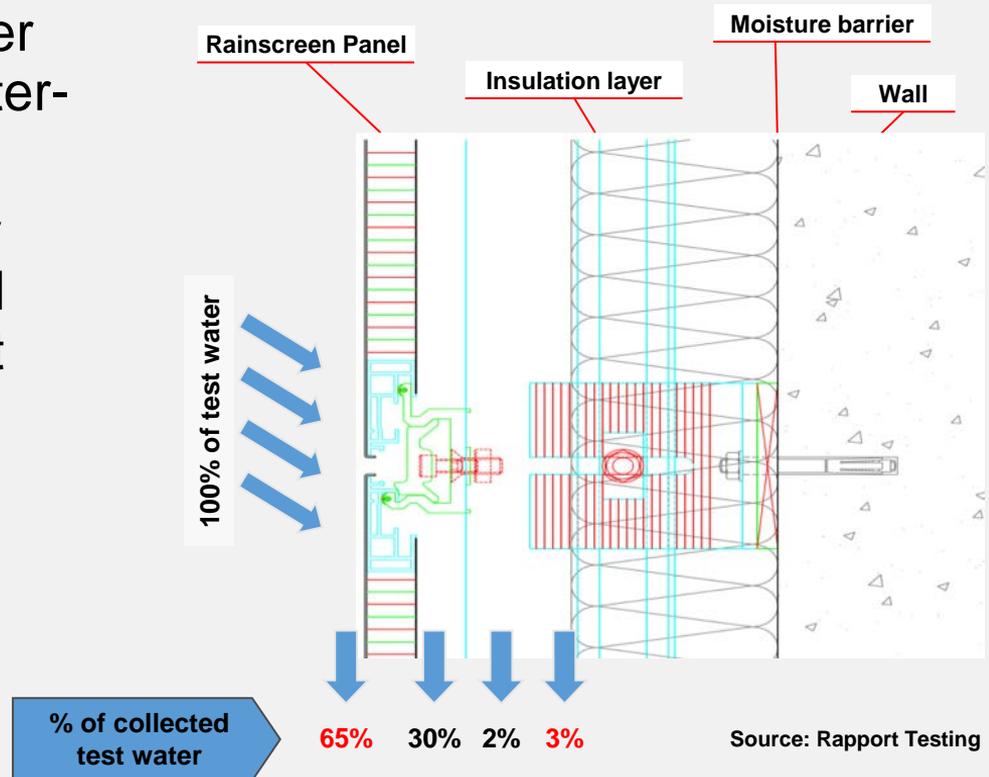
- Kinetic Energy
- Surface Tension
- Gravity
- Capillarity
- Air Pressure

Protected Opening: (The design of the tile joint (ship lap) is “key” to the performance of the Rainscreen.)

Rainscreen Façades

Rainscreen façades offer an effective, natural water-control system

Rainscreens do not rely on sealants, but instead minimize the forces that act on a building



Rainscreen Summary Advantages

- No sealants or gaskets.
- Outer layer protects inner layer from heavy wetting or soaking rain.
- Inner layer components (membrane, air seals, and other) are protected from UV degradation.
- Insulation can be added to increase building's thermal performance.
- Condensation is continually carried away by air movement known as the chimney effect or back-ventilation.
- Moisture is never trapped in the cavity, leading to mildew.

- **Rainscreen**

 - Understanding the Rainscreen Principle

- **Terracotta**

 - The Value of Terracotta as a Rainscreen Cladding

- **Design Options**

 - Design Considerations of Terracotta Rainscreen Façade

- **Façade Application**

 - Overview of Façade Types – Stick-Built, Panelized, Unitized, and Façade Refurbishment Case Study

Clay



Water



Fire

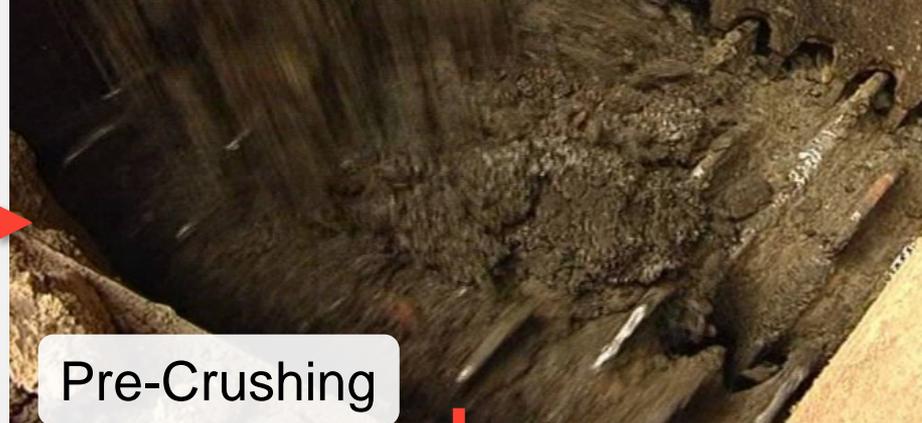




Clay Quarry



Excavator



Pre-Crushing



Roll Mill





Material preparation

Mix the components to a Homogeneous Mass

- 60% Clay (Amount Varies)
- 35% Grog (Recycled Clay – Amount Varies)
- 18% Water
- 0-4% Pigments/Additives

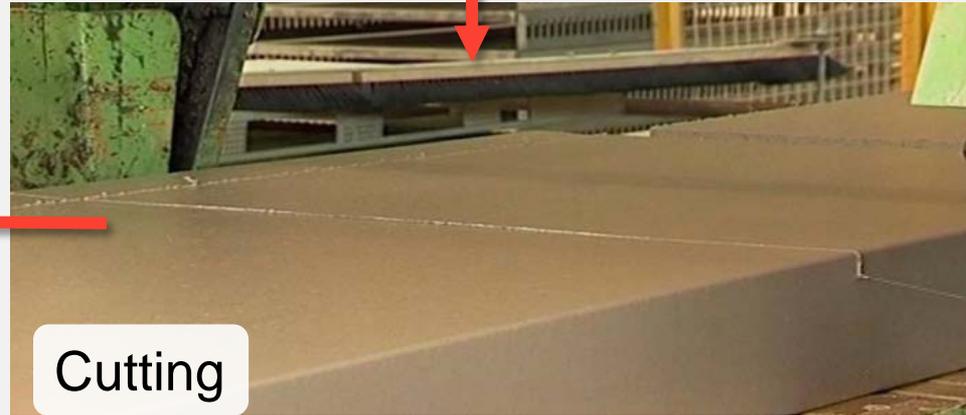
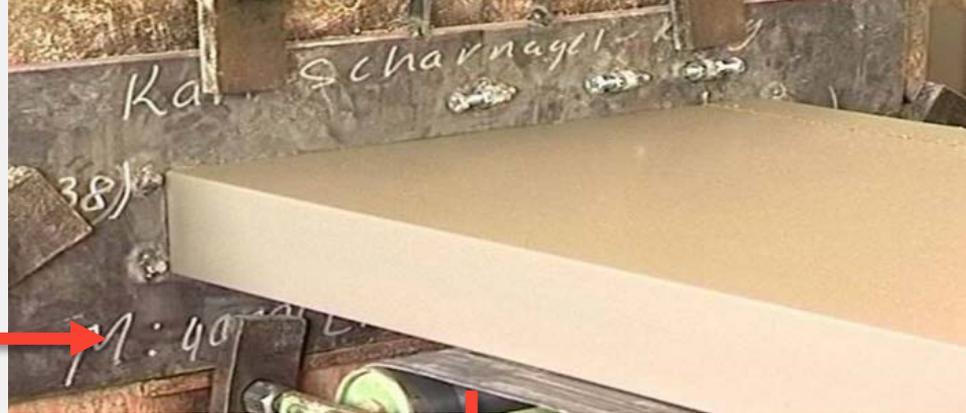
Pigments

- Chromatic Iron (Gray tones)
- Iron Oxide (Natural Red tones)
- Manganese (Dark Red/Brown tones)





Extrusion Press



Cutting



Drying Process

Gradually lowers moisture percentage in the material from 18% → 4.5%.



Firing Process

Two Different Types of Kilns

1. Box Kiln

- Firing process approximately 12 hours
- Best used for producing tiles with deep profiles
- (1000°C–1200°C)
- 8%–9% shrinking during firing



Box Kiln

Firing Process

Two Different Types of Kilns

2. Roller Kiln

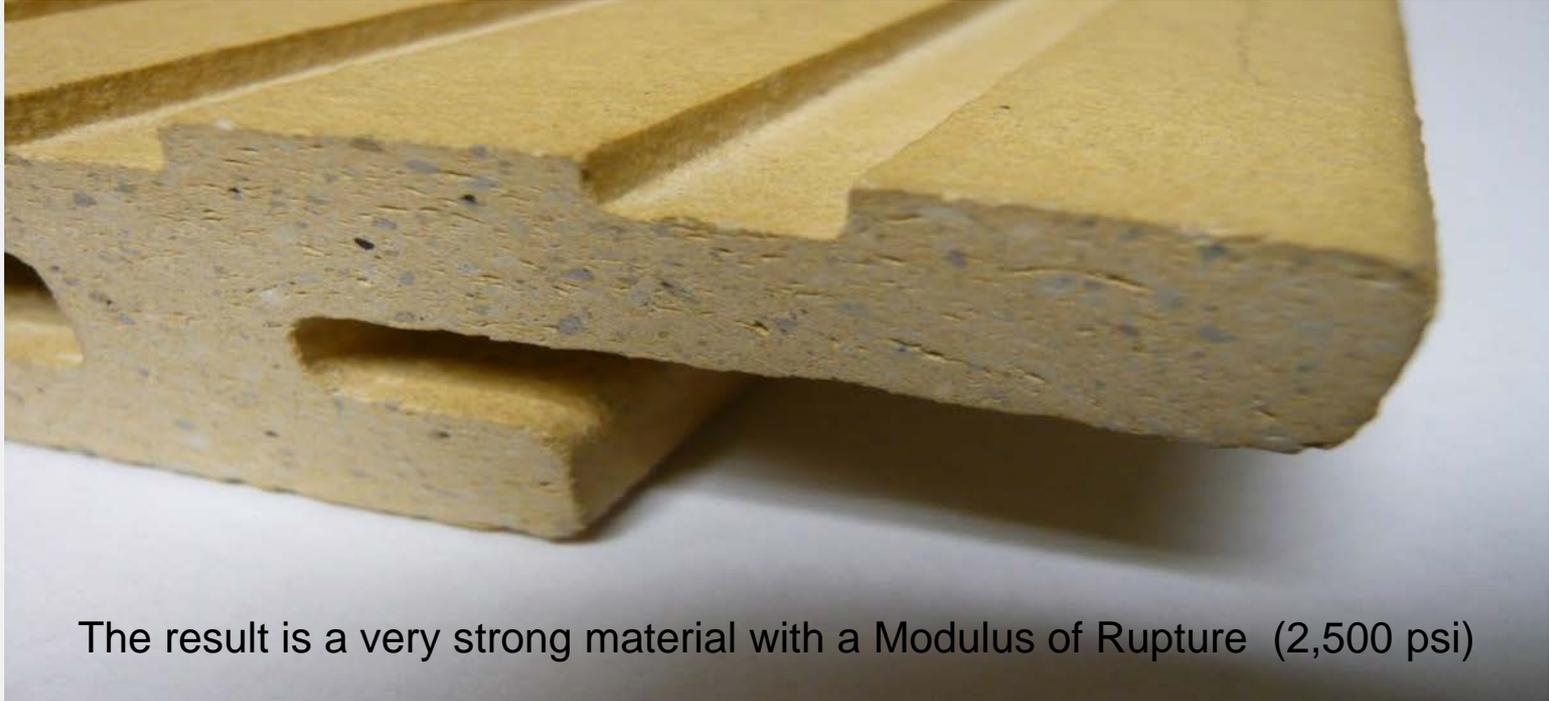
- Firing process approximately 6–8 hours
- Best used for producing flat tiles
- (1000°C–1200°C)
- 8%–9% shrinking during firing



Roller Kiln



Terracotta – Clay Tile Cross Section



The result is a very strong material with a Modulus of Rupture (2,500 psi)

- **Rainscreen**

 - Understanding the Rainscreen Principle

- **Terracotta**

 - The Value of Terracotta as a Rainscreen Cladding

- **Design Options**

 - Design Considerations of Terracotta Rainscreen Façade

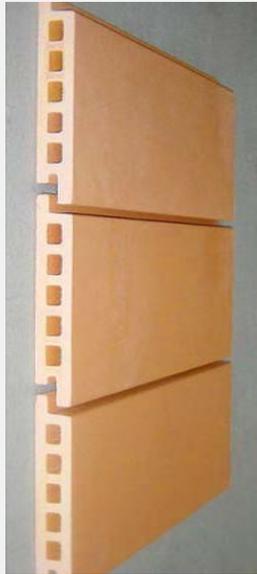
- **Façade Application**

 - Overview of Façade Types – Stick-Built, Panelized, Unitized, and Façade Refurbishment Case Study

Terracotta Types

40mm Tiles

(Large)



Max Dimension

- Height: 2 ft (600mm)
3'-0"
- 900mm Sp. Request
- Length: **6'-0"** (1824mm)
8'-10" (2692mm) Sp. Request
- Thickness: 1.5" (40mm)

30mm and 28mm Tiles

(Mid and Light)



Max Dimension

- Height: **20"** (508mm)
- Length: **5'-0"** (1524mm)
- Thickness: 1.118 (28mm)
- 1.25" (30mm)

20mm, 25mm, 30mm

(Solid-Precast)



Max Dimension

- Height: **2 ft** (600 mm)
- Length: **4 ft** (1219 mm)
- Note: **12" x 60"** (Also Available 30mm)



Terracotta Solid – Precast

Salt Lake City Public Safety Building
Precast Panels and Rainscreen



Terracotta Solid – Precast

BLOCH School of Business – Kansas City
Rainscreen – VE Precast



Natural Colors

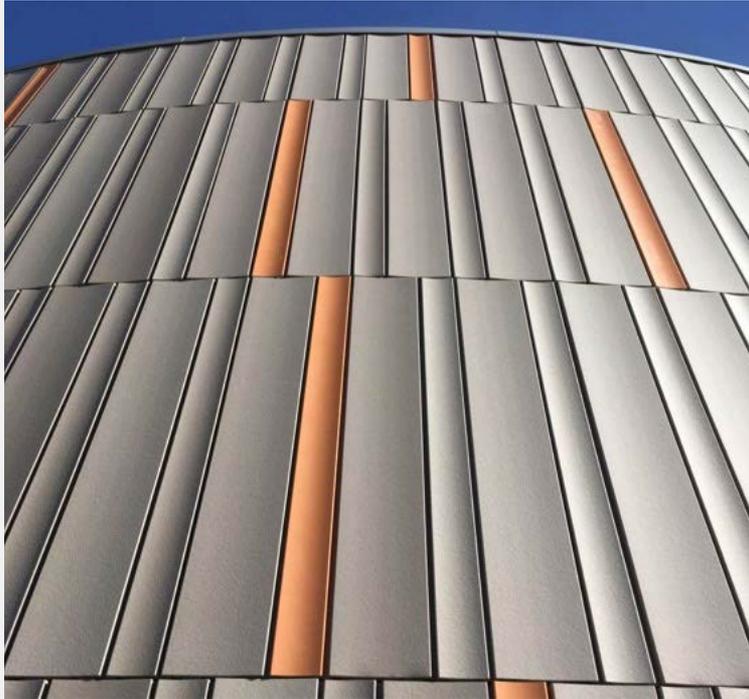
- Color depends on content and origin of the clay
- Colors may differ by clay pit
- Color also affected by the firing temperature
- Tile surfaces have a granular texture



Danforth Plant Sciences – St. Louis

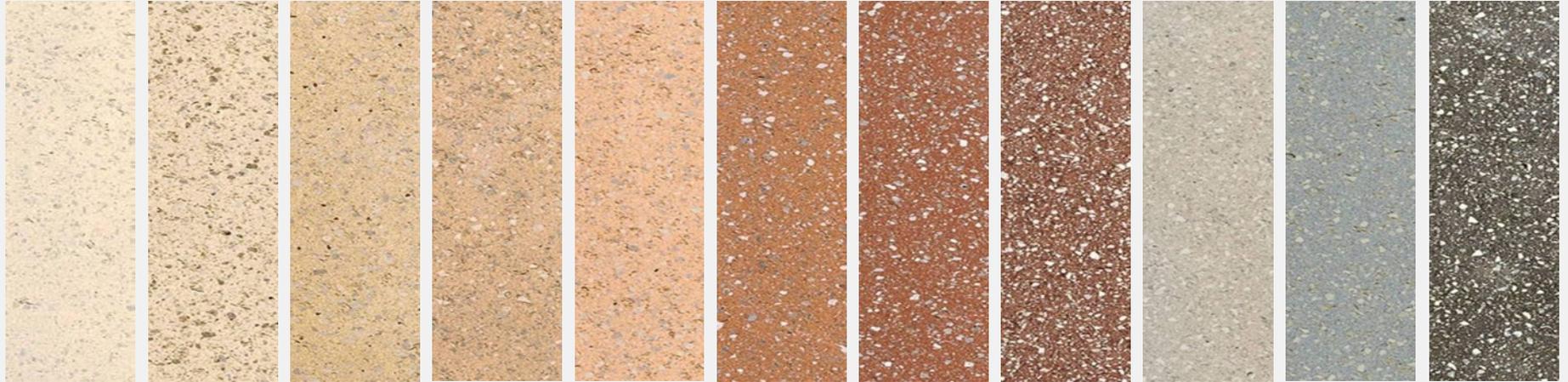


Danforth Plant Sciences – St. Louis

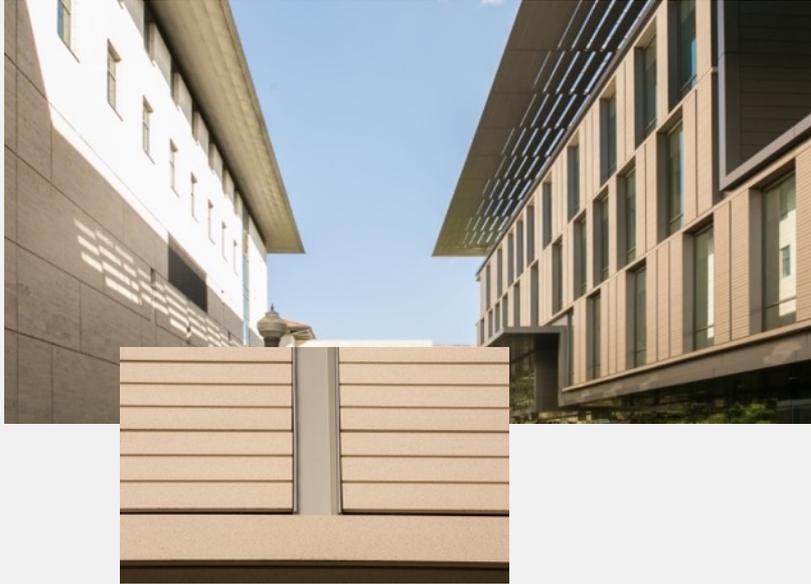


Honed Colors

- Smooth surface; mechanical process (ground flat) by wet sanding, leaving a smooth surface.
- Chamotte or Grog in clay shows the “aggregate” at the surface.



Material Choice: VE – Limestone – Honed Finish

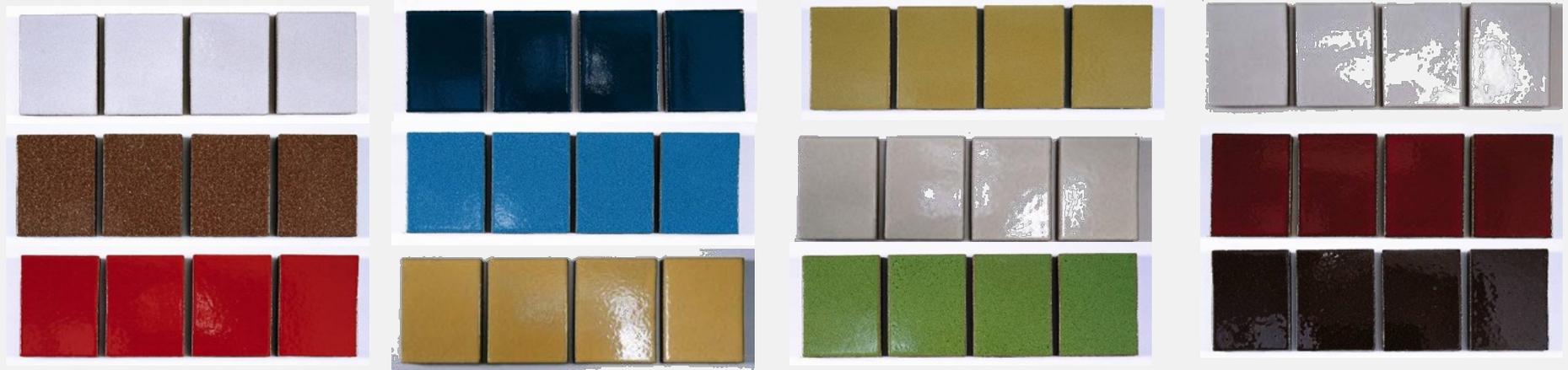


Project Reference: UT– Austin (Liberal Arts Building)
Architect: FRCH Design World Architects
Location: Austin, TX



Glazes

- Single-Fired Glaze
- Double-Fired Glaze (Higher Quality and Glazed Edges)
- Engobe (Slip Clay)



Type: Special Shapes, Transparent Green–Blue Glaze



Project Reference: Community Centre – Mainz, Germany
Architect: Manuel Herz

Type: Multi-colored Glazed Tiles and Baguettes



Project Reference: BSU, Hamburg, Germany
Architect: Sauerbruch Hutton Architects

Type: Multi-colored Glazed Tiles and Baguettes



Project Reference: BSU, Hamburg, Germany
Architect: Sauerbruch Hutton Architects

Type: Custom – Double Fired, Special Glazed Colors



Project Reference: Central St. Giles – London, UK
Architect: Renzo Piano Building Workshop

Type: Custom – Double Fired, Special Glazed Colors



Project Reference: Central St. Giles – London, UK
Architect: Renzo Piano Building Workshop

Type: Custom – Double Fired, Special Glazed Colors



Type: Custom – Double Fired, Special Glazed Colors



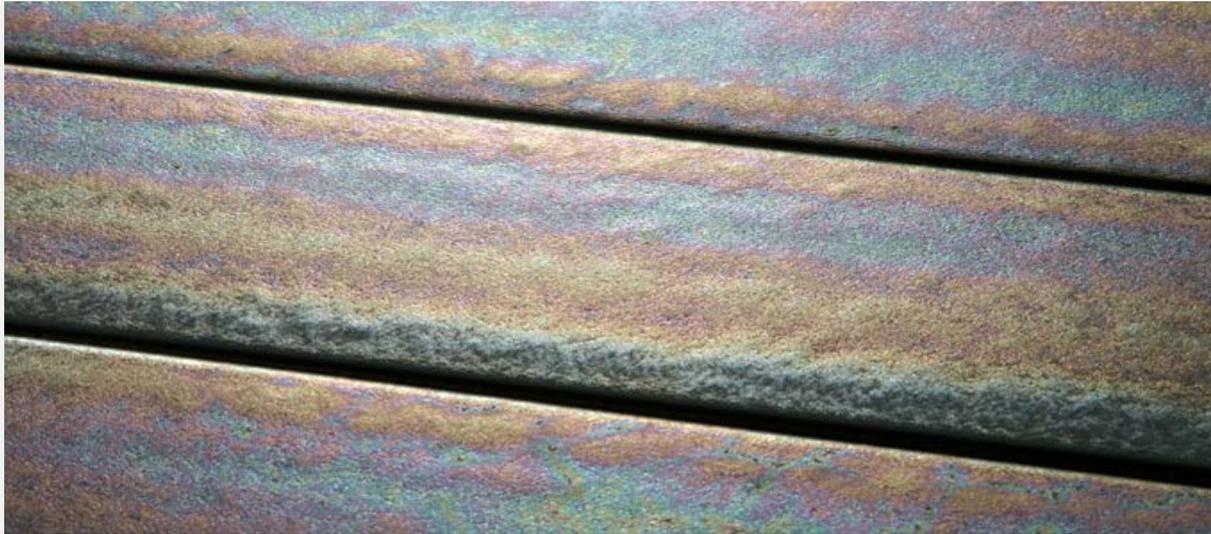
Project Reference: Central St. Giles – London, UK
Architect: Renzo Piano Building Workshop

Type: Custom – Double Fired, Special Glazed Colors



Project Reference: Central St. Giles – London, UK
Architect: Renzo Piano Building Workshop

Material Choice: Iridescent Glazed



Project Reference: Museum of Arts and Design (Jerome and Simona Chazen Building)
Architect: Allied Works Architecture
Location: New York City



Original building



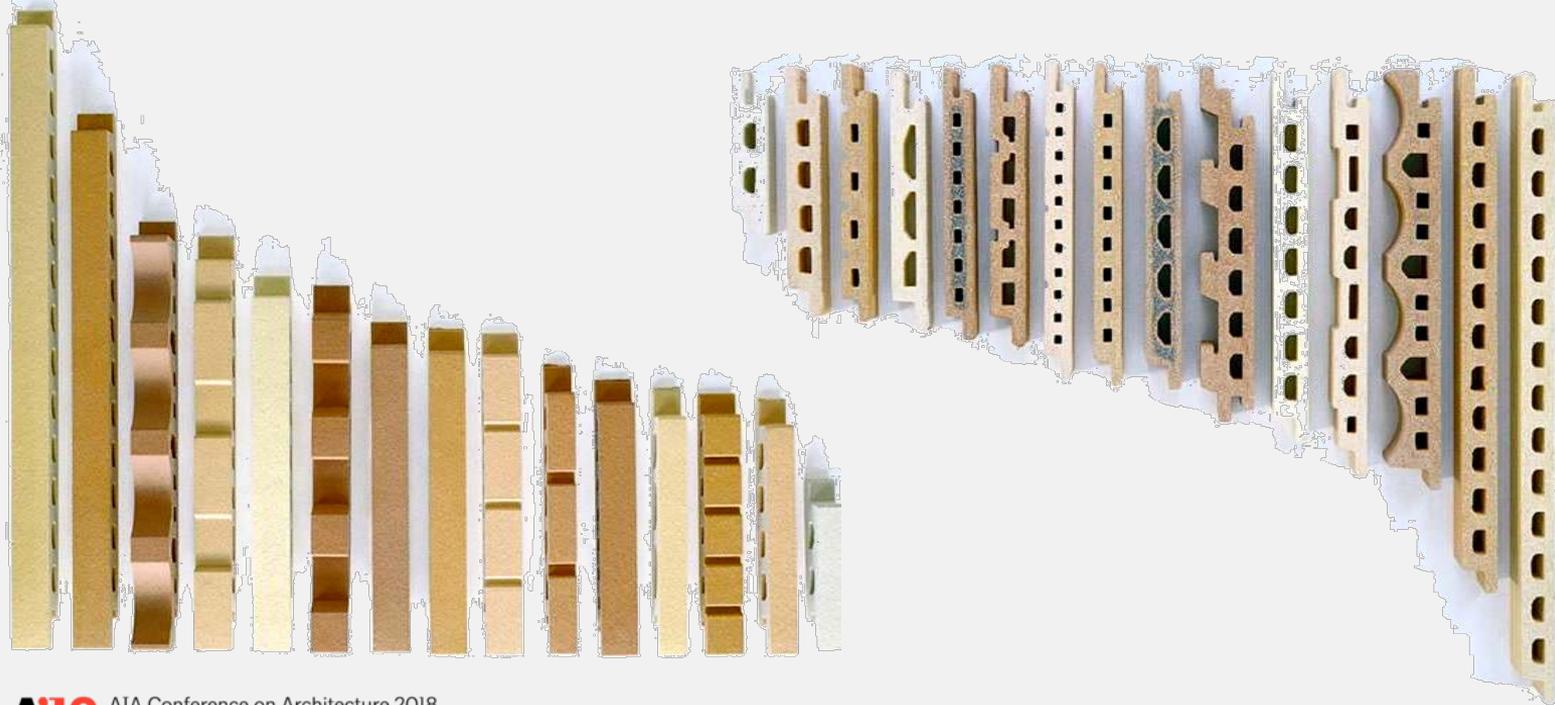
New building



Vertical Tiles – Reduction Fired Finish



Terracotta: Offers Architects Unlimited Design Flexibility, Combining Unique Profiles and Shapes to Create Texture



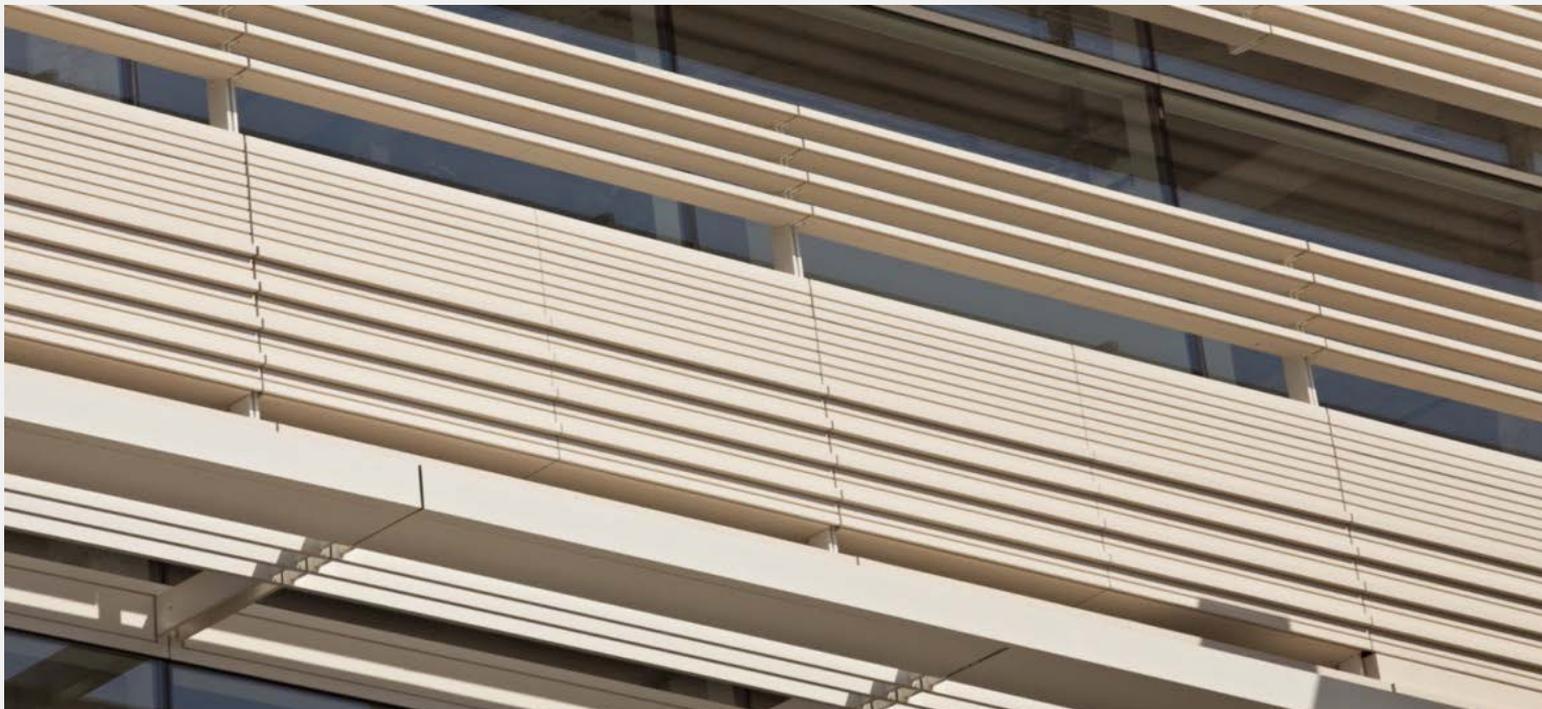
Material Choice: Profiled Tiles – Natural and Combed Finishes



Project Reference: T-Mobile – Chicago, IL
Architect: FRCH Design World Architects, Cincinnati, OH
Location: Chicago, IL



Project Reference: UCLA – Wasserman
Architect: Richard Meier
Location: Los Angeles, CA



Project Reference: UCLA – Wasserman
Architect: Richard Meier
Location: Los Angeles, CA



Project Reference: UCLA – Wasserman
Architect: Richard Meier
Location: Los Angeles, CA

Baguettes bring texture to overall façade



Baguettes and tile bring texture to the overall façade

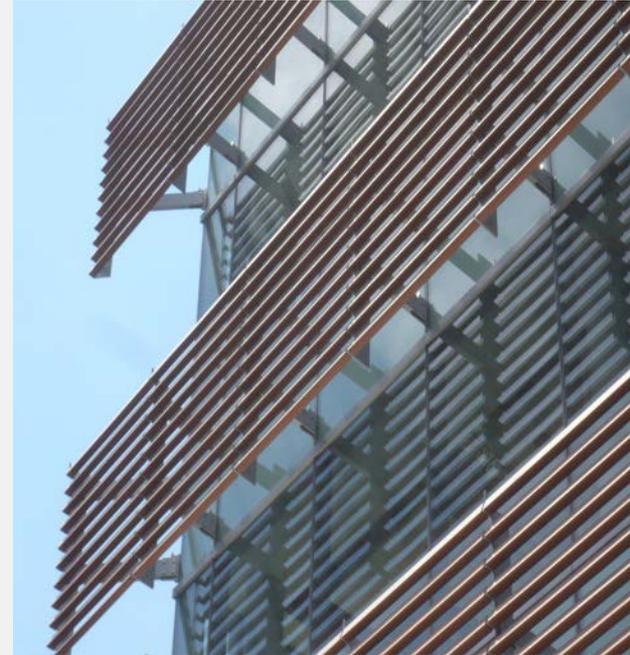


Project Reference: UMASS Amherst
Architect: Payette
Location: Amherst, MA

Baguette Screen Wall (UC – Berkeley Law)



Baguettes bring texture and “shade” as a Solar Screen



Project Reference: Boston Medical Center
Architect: TK&A
Location: Boston, MA

Round Baguettes (Interior Space)



Project Reference: KU—HEB (Health Education Building – Kansas City, MO)
Architect: CO Architects, LA and Helix Architecture – Kansas City, MO
Location: Kansas City, KS

Round Baguettes (Interior Space)



Project Reference: KU-HEB (Health Education Building – Kansas City, MO)
Architect: CO Architects, LA and Helix Architecture – Kansas City, MO
Location: Kansas City, KS



Project Reference: Ann Street Parking Garage – University of Michigan
Architect: Ennead Architects
Location: Ann Arbor, MI

Type: Baguette



Type: Baguette



A'18 AIA Conference on Architecture 2018
June 21-23, New York City

Project Reference: GeoSouthern
Architect: Kirksey Architecture
Location: Houston, TX

Baguettes Create a Sunshade Device





Project Reference: Münchwilen Courthouse
Architect: Abraha Achermann
Location: Switzerland

Vertical Baguettes – Glazed



Project Reference: Kirkland Museum – Denver, CO
Architect: Olson Kundig Architects
Location: Seattle, WA

Vertical Baguettes – Glazed (4 Colors)



Project Reference: Kirkland Museum – Denver, CO
Architect: Olson Kundig Architects
Location: Seattle, WA

Double Glazed Baguettes



Project Reference: Kirkland Museum – Denver, CO

Architect: Olson Kundig Architects

Location: Seattle, WA

Vertical Baguettes (Natural Finish)



Project Reference: Marmalade City Library – Salt Lake City, UT

Architect: Blalock and Architects

Location: Salt Lake City, UT

Vertical Baguette Fins

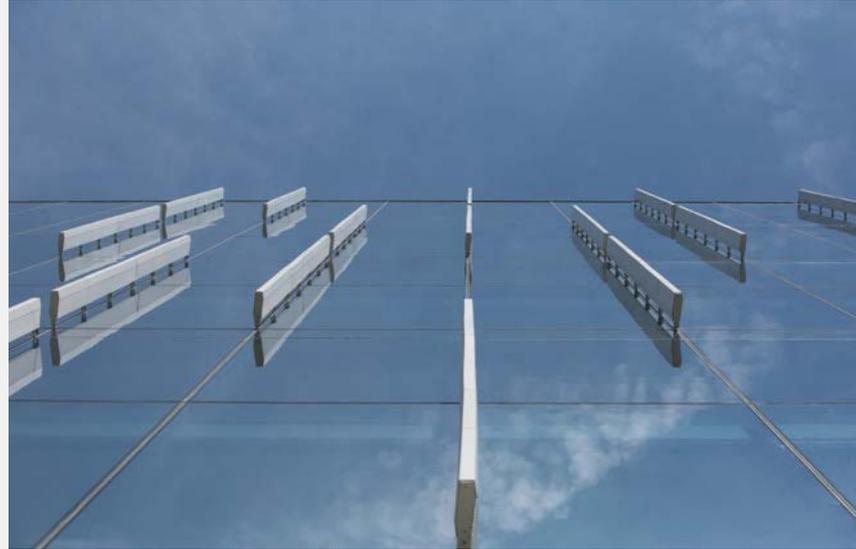


Project Reference: 1333H – Washington, DC

Architect: Architects – Gensler

Location: Washington, DC

Vertical Baguette Fins

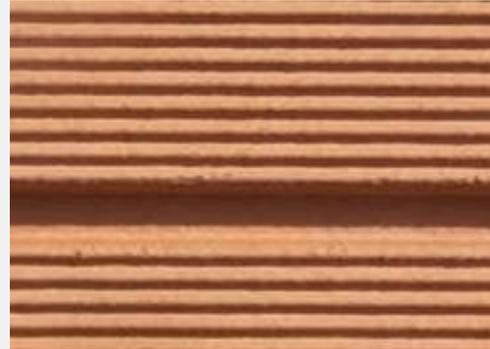


Project Reference: 1333H – Washington, DC

Architect: Gensler

Location: Washington, DC

Textures



Material Choice: Textured (Natural, Wire Struck, Grooved)



Project Reference: Children's Hospital (CHOP) – Philadelphia
Architect: Ballinger
Location: Philadelphia, PA

Baguettes and Tiles Bring Texture (Wire Struck and Profile)



Project Reference: Boston Medical Center
Architect: TK&A
Location: Boston, MA

Terracotta Complements Brick of 150 Years and the 20's



A'18 AIA Conference on Architecture 2018
June 21-23, New York City

Project Reference: Boston Medical Center
Architect: TK&A
Location: Boston, MA

Type: Baguette and Profiled Textured



Project Reference: Boston Medical Center
Architect: Tsoi/Kobus

- **Rainscreen**

 - Understanding the Rainscreen Principle

- **Terracotta**

 - The Value of Terracotta as a Rainscreen Cladding

- **Design Options**

 - Design Considerations of Terracotta Rainscreen Façade

- **Façade Application**

 - Overview of Façade Types – Stick-Built, Panelized, Unitized, and Façade Refurbishment Case Study

Terracotta facades can be stick-built, panelized or unitized depending on project needs

Stick-built Construction



Panelized Construction



Unitized Construction



Façade Applications:

1. Stick Built (“Hand Set”)

2. Panelized

3. Unitized

Stick-built Installation Sequence (1 of 3)

Moisture barrier (peel-and-stick) applied to sheathing



Water-proofing applied after system attachments installed



Stick-built Installation Sequence (2 of 3)

Rigid or semi-rigid insulation applied before verticals



Vertical rails applied after insulation to adjustable girt



Stick-built Installation Sequence (3 of 3)

Tile installation is non-progressive
(all tiles individually removable)



Final installation provides clean aesthetics
with high-performance layers underneath



Stick-built Installation Sequence

Moisture barrier (peel-and-stick) applied to sheathing with subgirt system installed



Semi-rigid mineral wool insulation on membrane



Stick-built Installation Completed



Stick-built installation sequence on CMU (Cement Masonry Unit)

Installation of Wall Bracket to CMU



Installation of Vertical Carrier to CMU



Installation of Tiles and Clips Carriers



Tile Installed



Vertical Application – Stick-Built

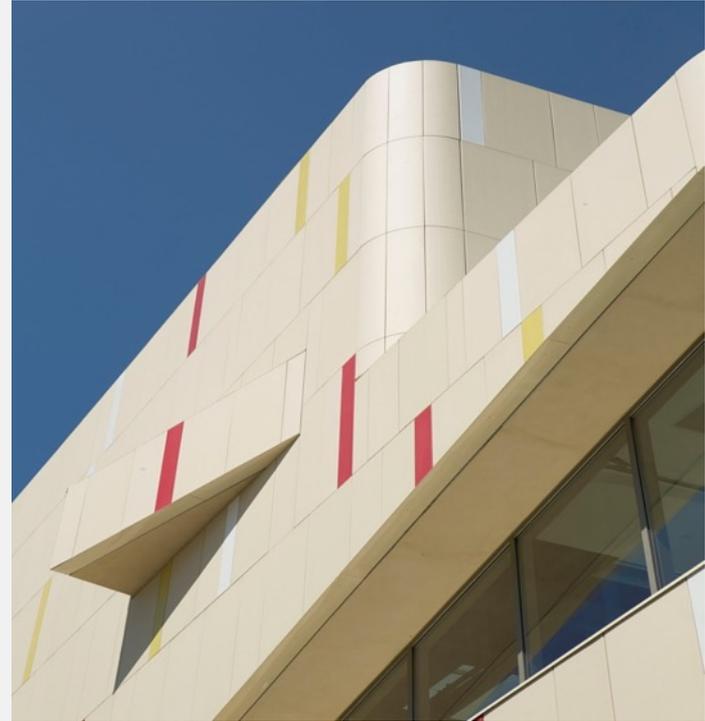
Installation of Tiles



Tile Installed



Material Choice: Vertical Tiles – Natural and Engobe



Façade Applications:

1. Stick Built (“Hand Set”)

2. Panelized

3. Unitized

Emerson College – Panelized – Shop Fabrication (1 of 3)



Emerson College – Panel Ready for Installation (2 of 3)



Emerson College – Panelized Installation (3 or 3)



Panelized – Field Installation Video



Panelized Installation with Windows (1 of 3)



Panelized Installation with Windows (2 of 3)



Panelized Installation with Windows (3 of 3)

Fabricated Panel on Metal Studs



Corner Detail



Panelized Wall Installation



Building Elevation



Façade Applications:

1. Stick Built (“Hand Set”)

2. Panelized

3. Unitized

Unitized Curtain Wall Fabrication



Project Reference: Yale New Haven Hospital
Architect: Shepley Bulfinch Richardson Abbot – Boston, MA
Location: New Haven, CT

Unitized Curtain Wall Application



Project Reference: Yale New Haven Hospital
Architect: Shepley Bulfinch Richardson Abbot – Boston, MA
Location: New Haven, CT

Unitized Curtain Wall Installation



A18 AIA Conference on Architecture 2018
June 21-23, New York City

Project Reference: Yale New Haven Hospital
Architect: Shepley Bulfinch Richardson Abbot – Boston, MA
Location: New Haven, CT

Unitized Installation Sequence

Unitized Curtain Wall



Terracotta Panel after Installation



Final Positioning of Unitized Panel



Terracotta "Unit Wall" Panels on Building Structure

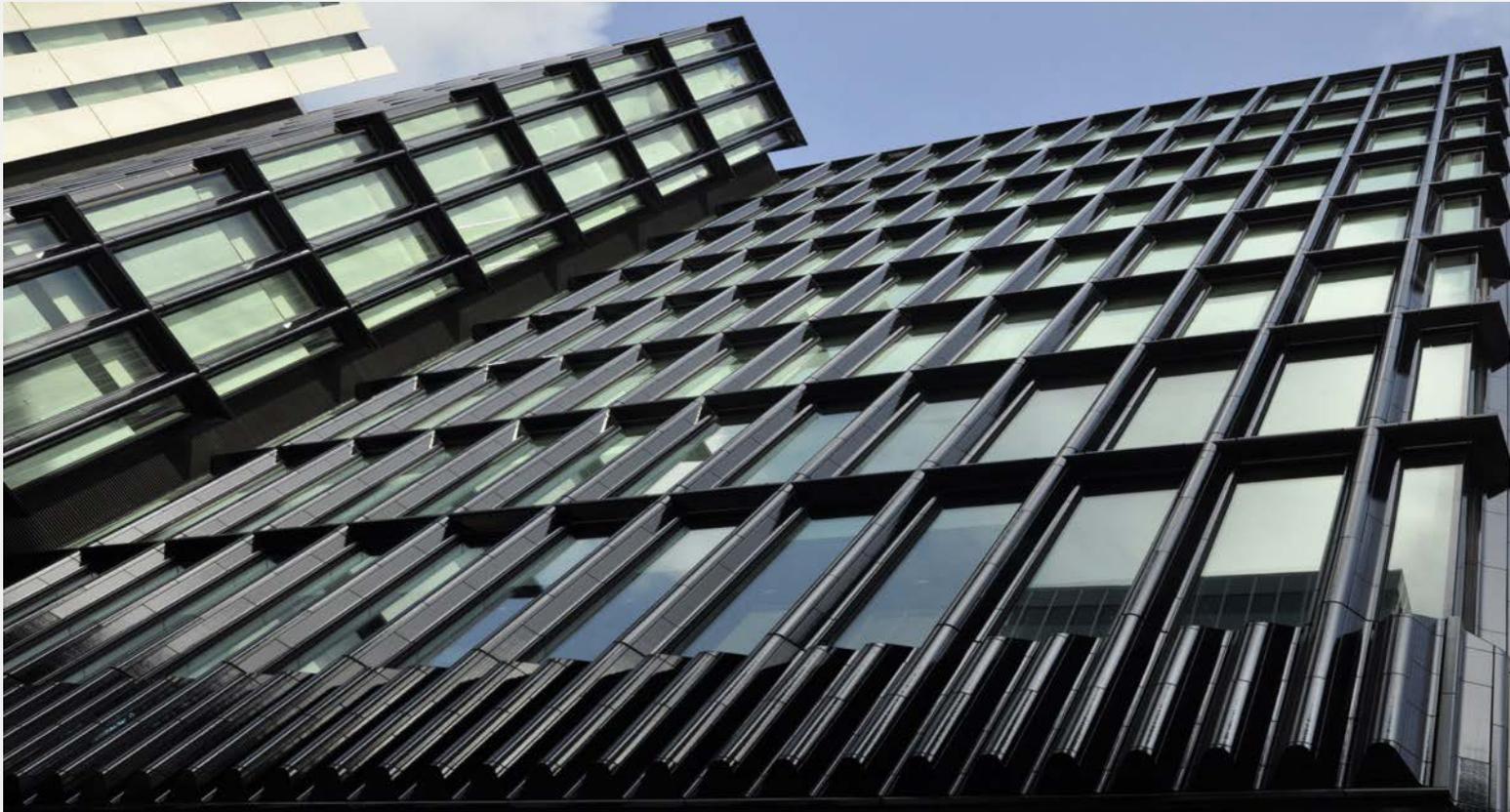


Unitized Curtain Wall Installation Completed



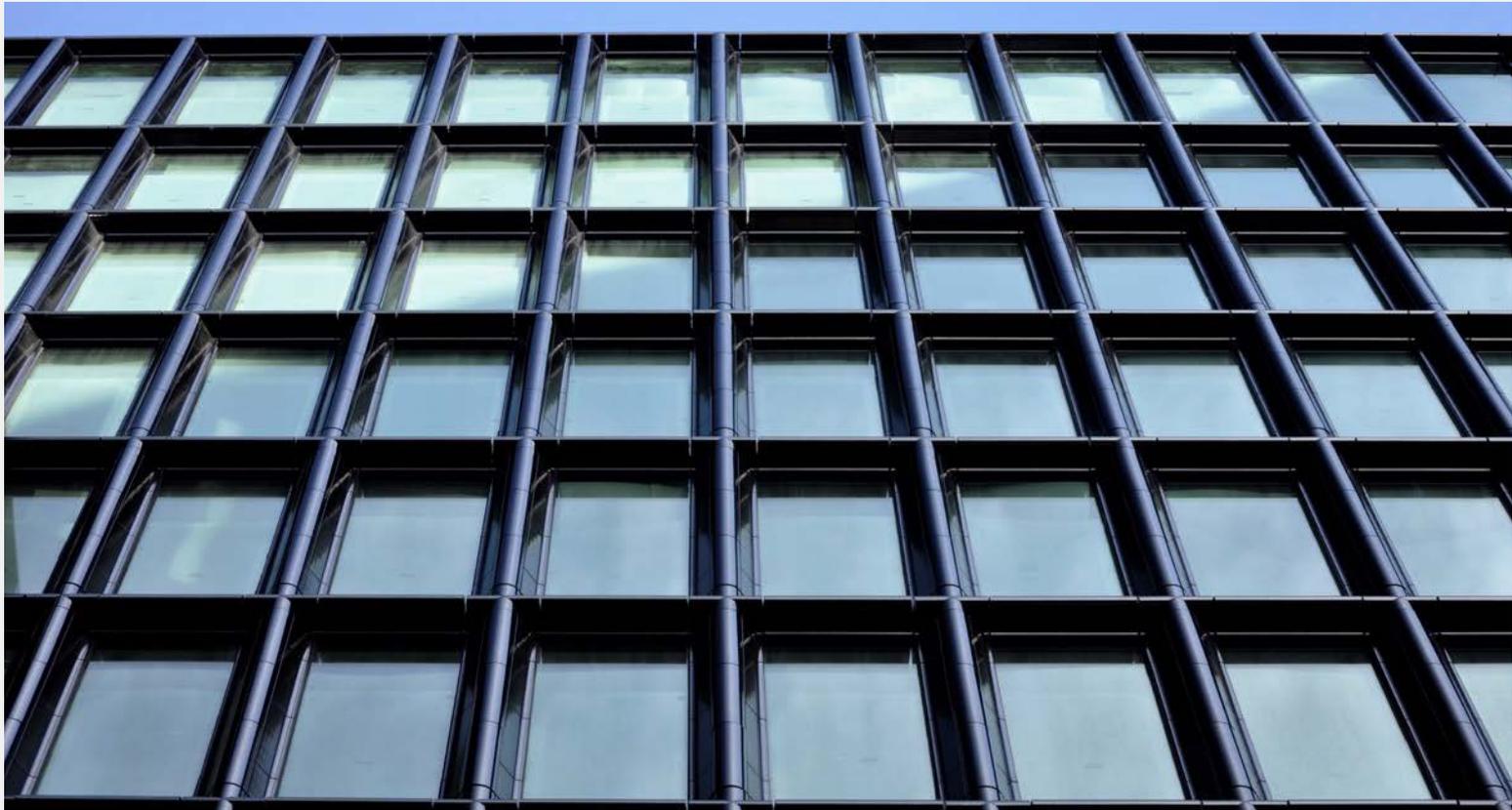
A18 AIA Conference on Architecture 2018
June 21-23, New York City

Project Reference: Memorial Sloan-Kettering
Architect: Skidmore, Owings & Merrill
Location: New York, New York



A18 AIA Conference on Architecture 2018
June 21-23, New York City

Project Reference: London Wall Place
Architect: Make
Location: London, UK



A18 AIA Conference on Architecture 2018
June 21-23, New York City

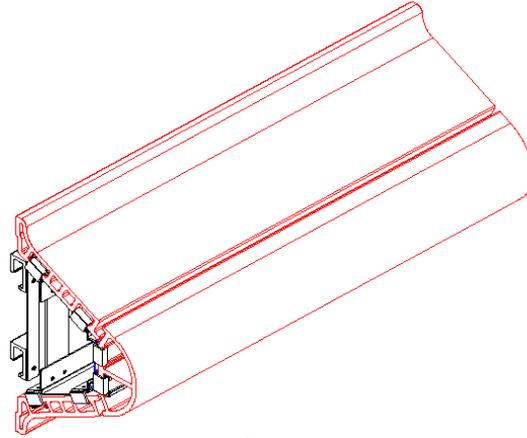
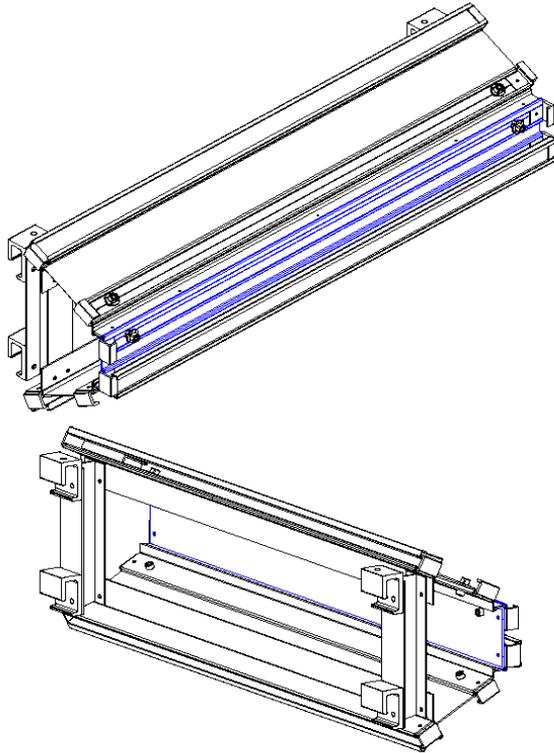
Project Reference: London Wall Place
Architect: Make
Location: London, UK



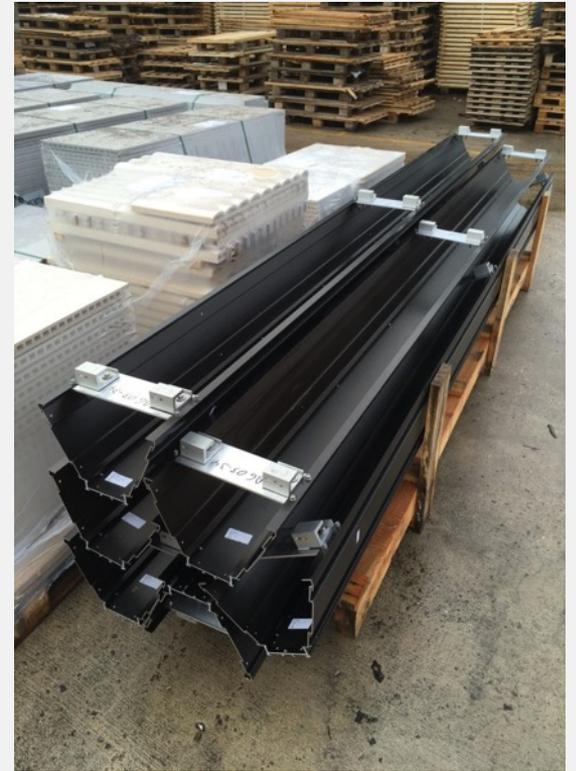
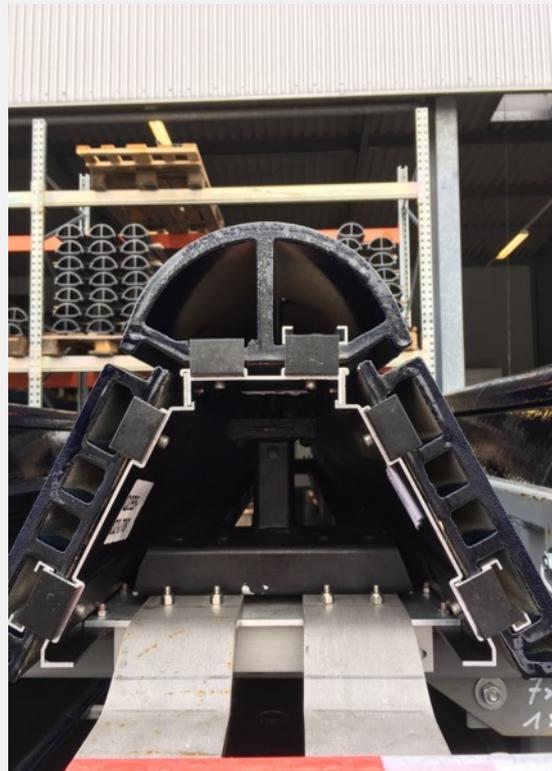
A18 AIA Conference on Architecture 2018
June 21-23, New York City

Project Reference: London Wall Place
Architect: Make
Location: London, UK

Diese Zeichnung ist unser Eigentum. Jede Vervielfältigung, Verwertung oder Weitergabe an dritte Personen ist verboten und wird verfolgt.



London Wall
drg. M-01-002 3C





Vertical Application



Project Reference: 111 West 57th Street
Architect: SHoP Architects/Developer: JDS Development
Tiles: Unitized Curtain Wall

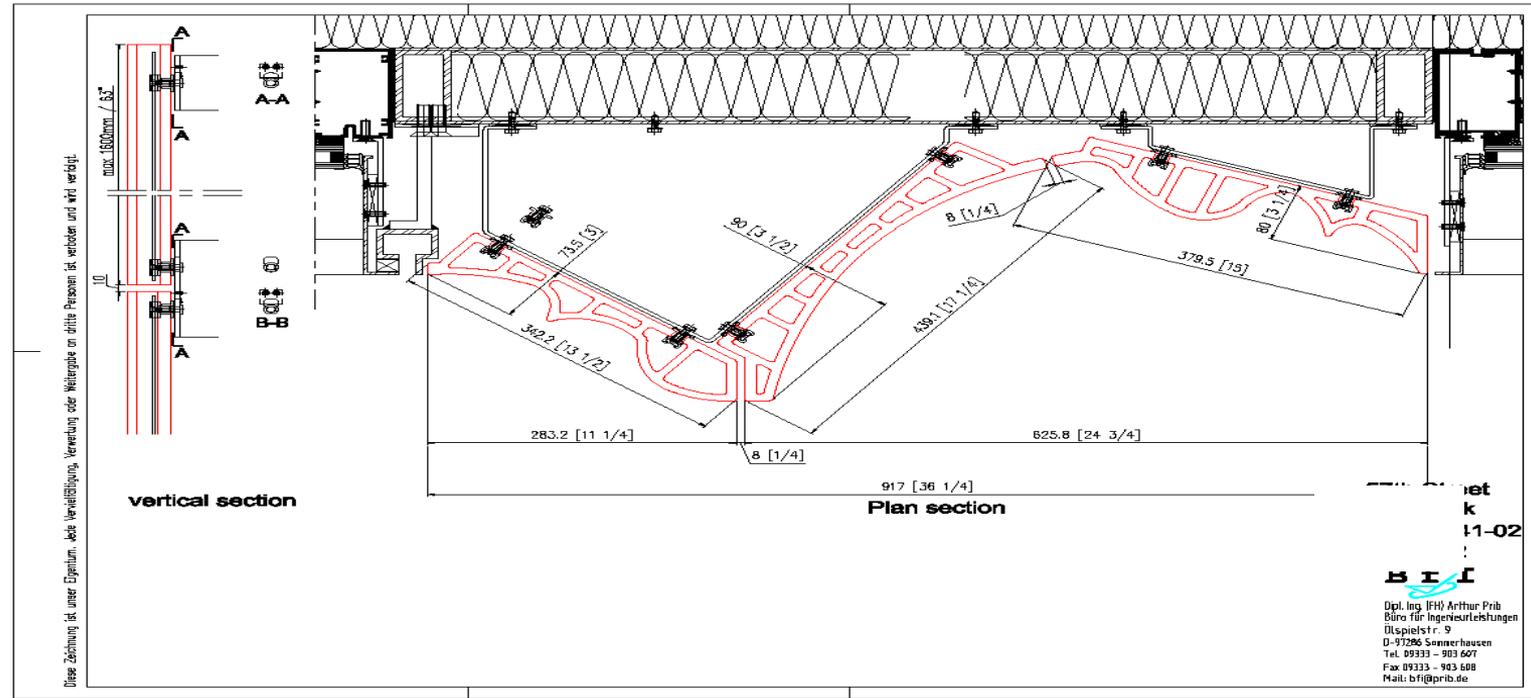
Vertical Application



A18 AIA Conference on Architecture 2018
June 21-23, New York City

Project Reference: 111 West 57th Street
Architect: SHoP Architects/Developer: JDS Development
Tiles: Unitized Curtain Wall, Back-Fixed Hardware

Vertical Application



Project Reference: 111 West 57th Street
Architect: SHoP Architects/Developer: JDS Development
Tiles: Unitized Curtain Wall, Back-Fixed Hardware

Vertical Application



Design Inspiration: Woolworth Building, New York City



Project: 111 West 57th Street • New York City

Architect: SHoP Architects/Developer: JDS Development

Vertical Application



Vertical Application



Project Reference: 111 West 57th Street
Architect: SHoP Architects/Developer: JDS Development
Tiles: Unitized Curtain Wall

Vertical Application



Façade Refurbishment Case Study



Project Reference: 215 East 68th Street • New York, NY
Architect: FXFOWLE & Forst Consulting and Architecture

Façade Refurbishment Case Study

Presented by

Mike Cleere

Director of Façade Engineering

NBK North America

Before Restoration

- 34-story central tower flanked by 21-story east and west wings
- Approx. 251,000 sq.ft. of wall area
- Built in 1962
- Concrete structural frame
- Glazed veneer face brick with 1" cavity and cinder block back-up





After Restoration

- New rainscreen façade using terracotta tiles
- Minimized impact on residents
- Improved performance



Why Refurbish?

- Fix failing façade
- Update aesthetics
- Improve temperature control
- Enhance durability
- Reduce maintenance requirements

Steps for Refurbishment

- Evaluate Design Options
- Survey
- Tag (Fabrication) Drawings
- Installation

Possible Design Scenarios

- Replace existing brick veneer wall
- Replace with new brick cavity wall
- Replace with new terracotta rainscreen system
- Replace with unitized curtain wall
- Replace with steel stud panelized wall
- Replace with 6" engineered brick wall



**Initial Visual
Mock-ups
Brick & Terracotta**



**Pre-bid Construction
Mock-ups
Brick Cavity Wall**

Pre-bid Construction Mock-ups

Brick Cavity Wall

Challenges

- Custom reinforcing material (not readily available)
- Normal anticipated masonry maintenance
- Add horizontal and vertical control joints to handle movement in the veneer
- Provide a similar look appropriate for a residential building

Pre-bid Construction Mock-ups

Terracotta Rainscreen

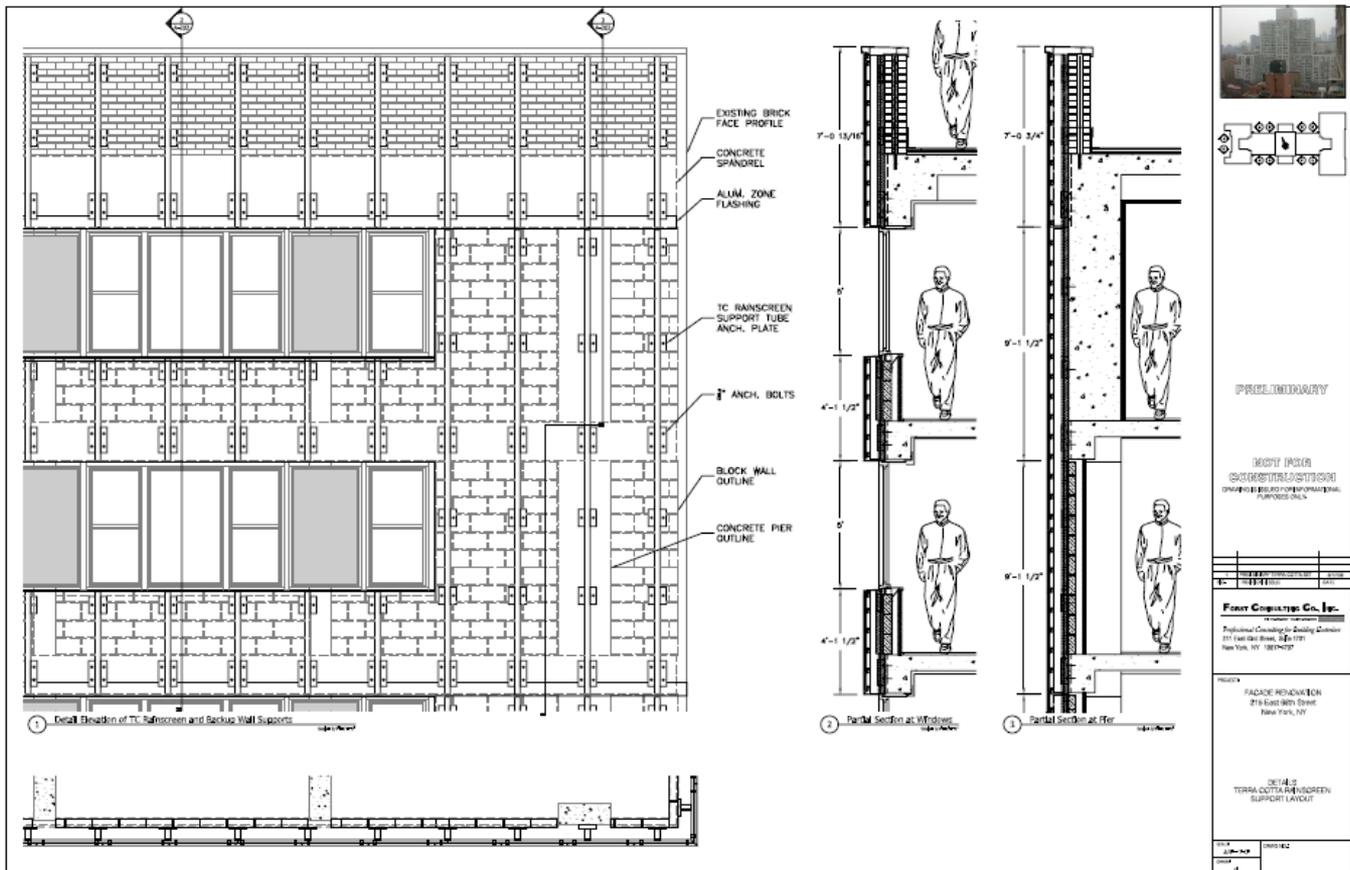


Pre-bid Construction Mock-ups

Brick Cavity Wall

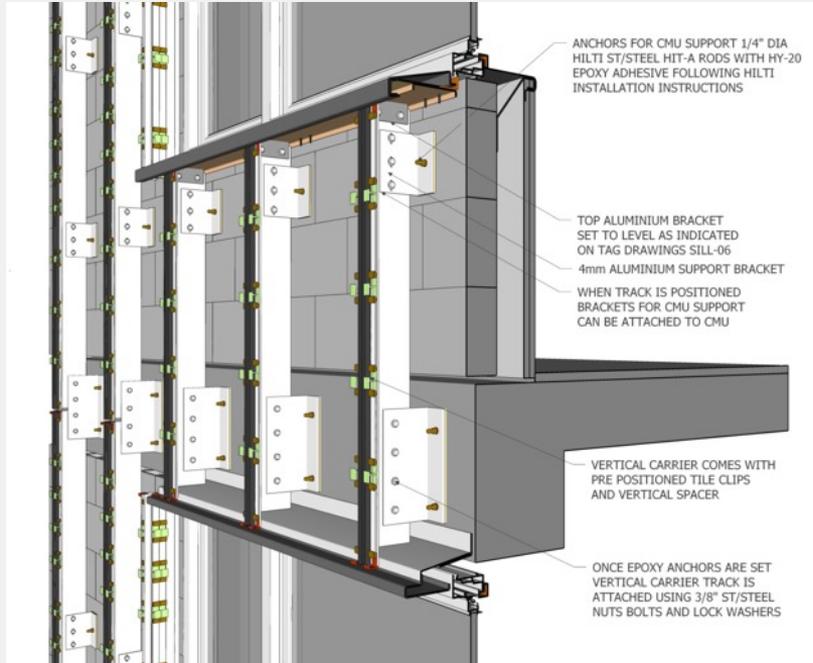
Opportunities

- Speed of installation
- Lower anticipated maintenance
- New cladding allows for movement
- Ventilated cavity with better drying characteristics
- Appearance resembles original design and is appropriate for a residential building

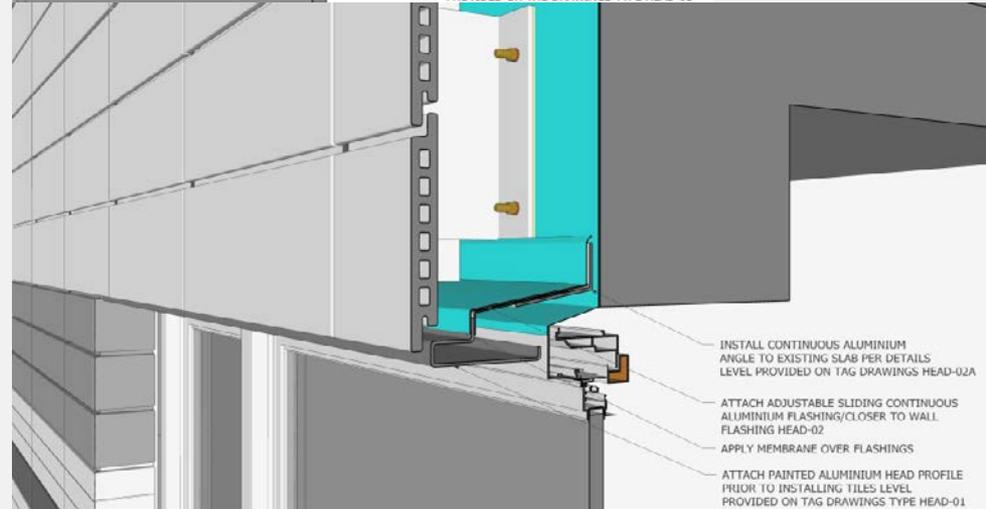
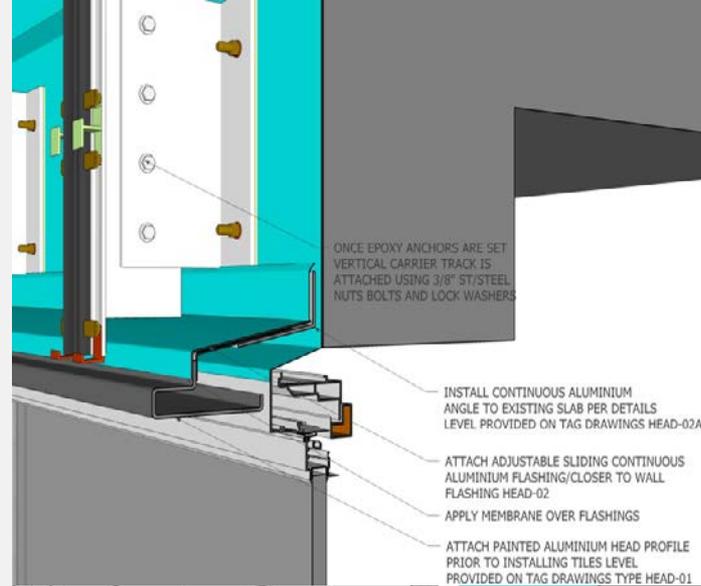


The System

Design Criteria



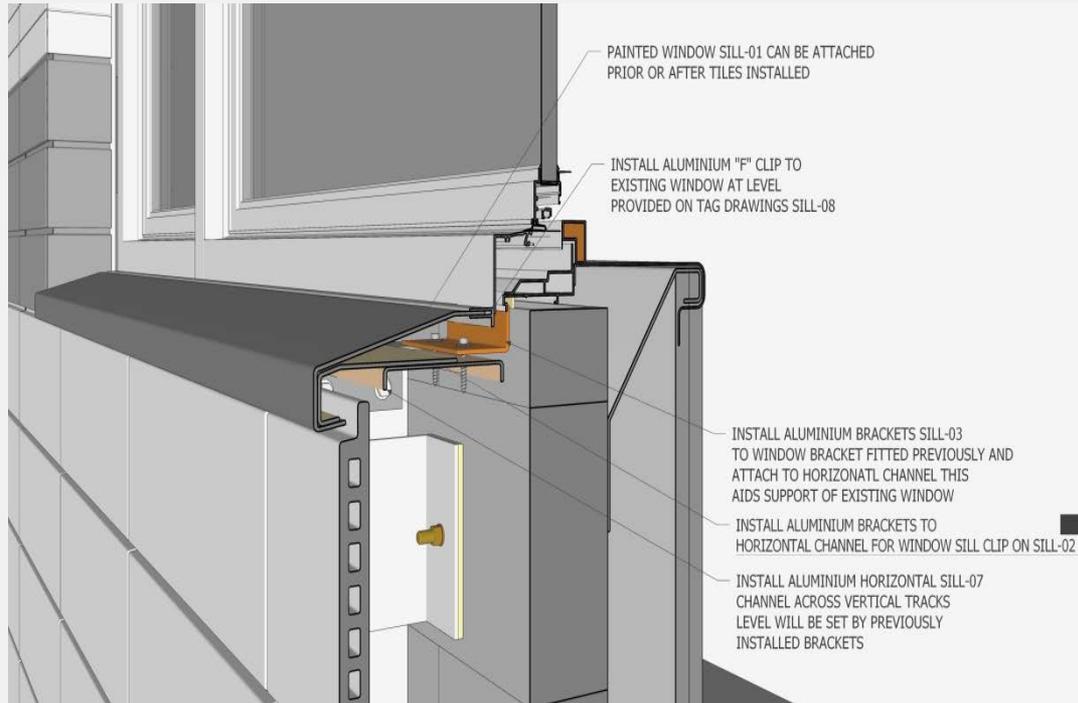
Window Head Trim Assembly



Window Coping Sill Assembly



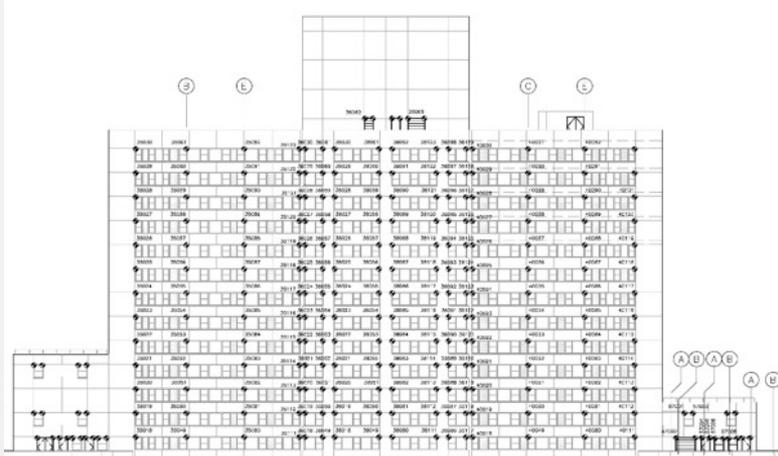
Window Coping Sill Assembly



Steps for Refurbishment

- Evaluate Design Options
- Survey
- Tag (Fabrication) Drawings
- Installation

Typical Survey Information



POINT DATA							
Number	Coordinate			Description			
	X	Y	Z	Raw	Plane	Jamb	Floor
1000	-19.14	11.95	19.99	01+A+02	1	A	2
1001	-19.16	11.99	29.09	01+A+03	1	A	3
1002	-19.15	11.96	38.22	01+A+04	1	A	4
1003	-19.17	11.96	47.31	01+A+05	1	A	5

Survey Results

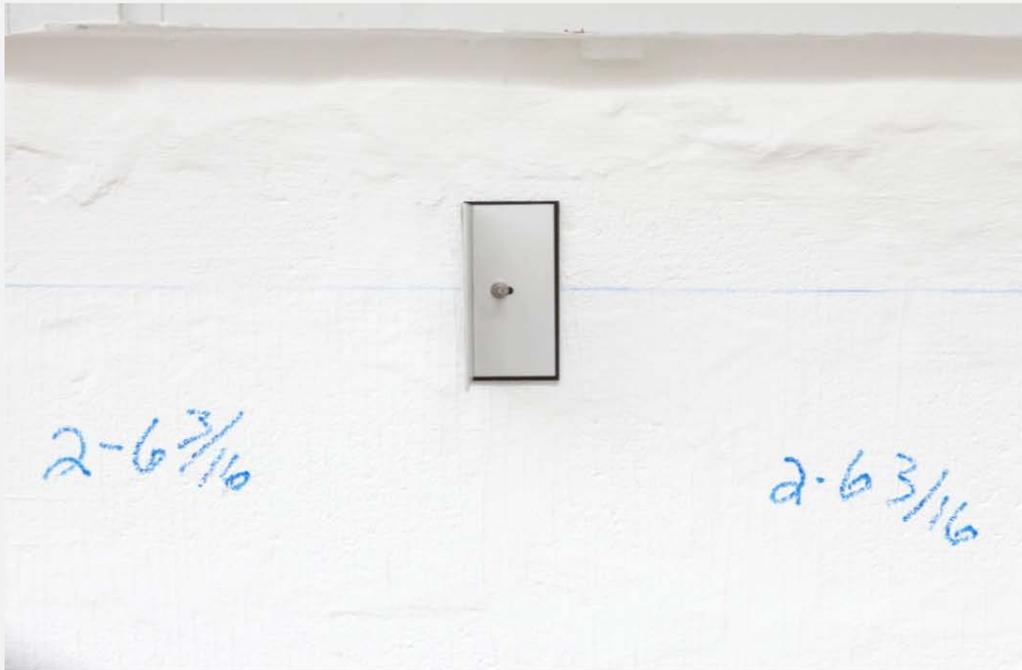
- Typical **upper floor** resulted in approximately **96 tag drawings** per floor
- Typical **lower floor** resulted in approximately **232 tag drawings** per floor

Steps for Refurbishment

- Evaluate Design Options
- Survey
- Tag (Fabrication) Drawings
- Installation



Wall Bracket Installation with Thermal Spaces



**Wall Bracket Layout
(Survey)**



Steps for Refurbishment

- Evaluate Design Options
- Survey
- Tag (Fabrication) Drawings
- **Installation**

Installation Procedure

- Staging
- Demolition
- Asbestos Abatement
- Pointing
- Waterproofing
- Framing
- Insulation
- Tile Installation



Staging



Demolition



Demolition



Demolition



Demolition



Pointing



Waterproofing



Waterproofing



Waterproofing



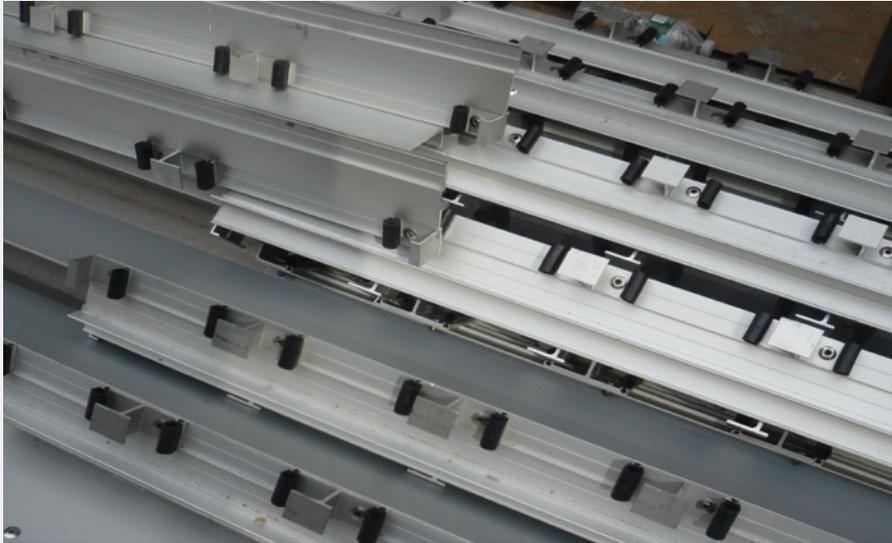
Framing (Anchors)



Framing



Framing



Framing



Insulation

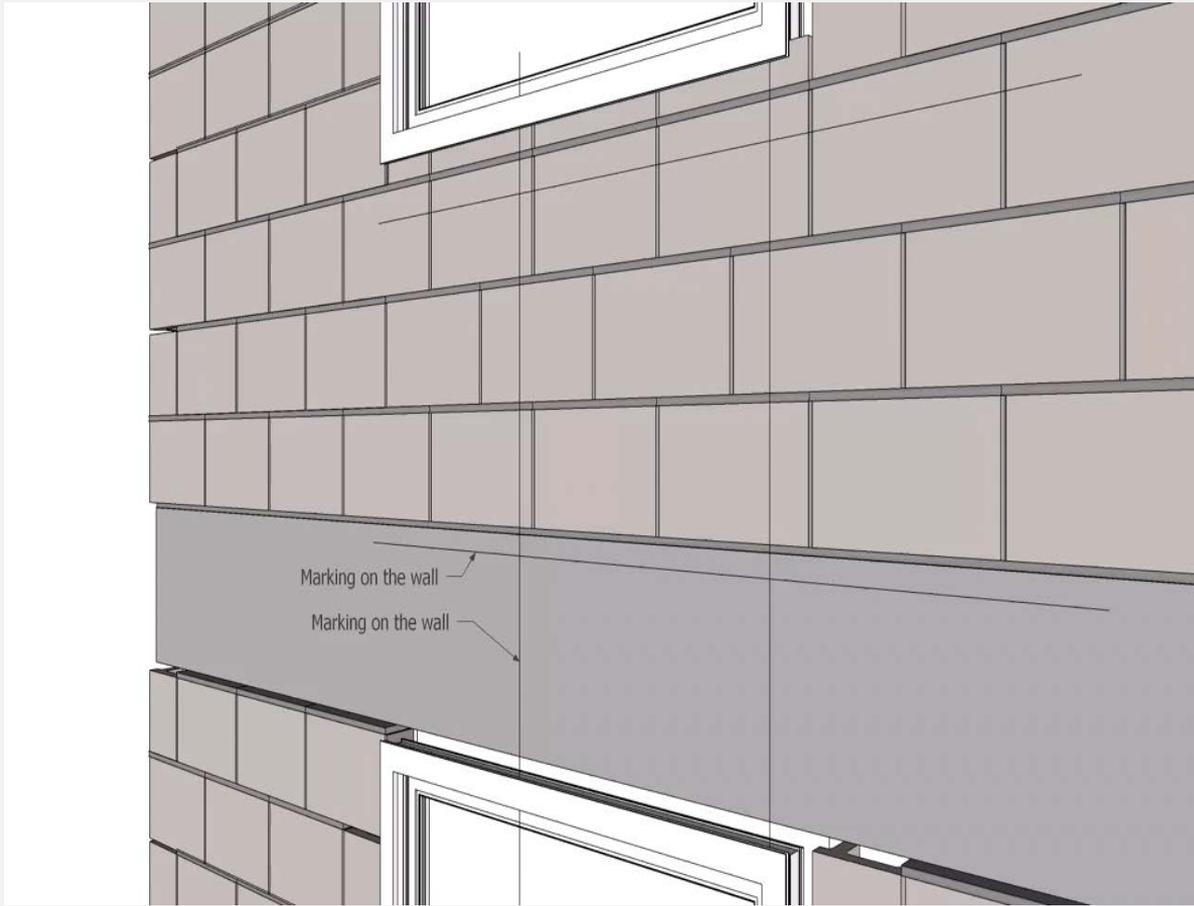


Improved Performance of Wall Cavity

Installed 3" semi-rigid, mineral-wool-fibre insulation
to outer face of weather-tight CMU wall

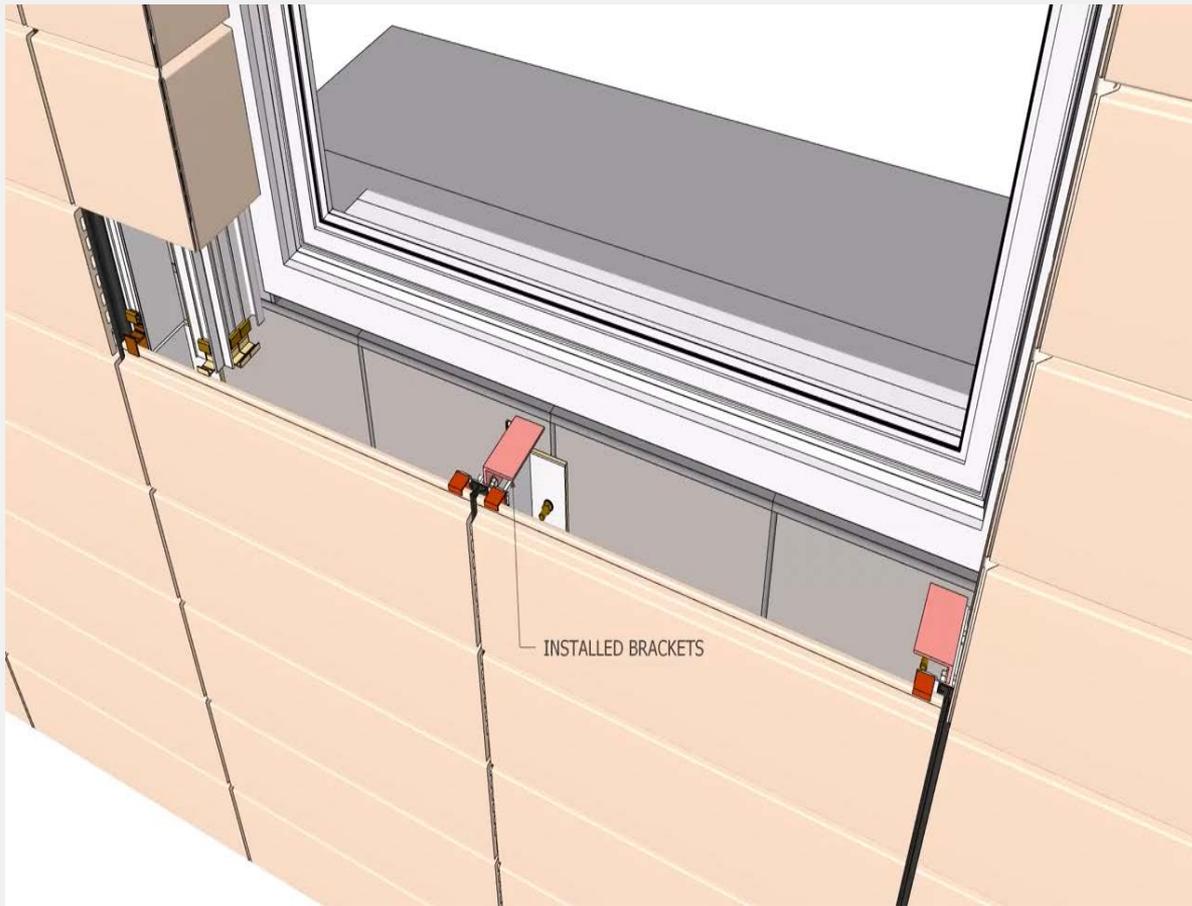
Results

- Better acoustical performance by avoiding the installation of wall brackets off vertical carrier tracks that penetrate the membrane
- Thermal resistance—isolator pads
- 3x thermal performance of original 1962 wall, reducing heat loss
- Water repellent
- Non combustible
- Vapor permeable



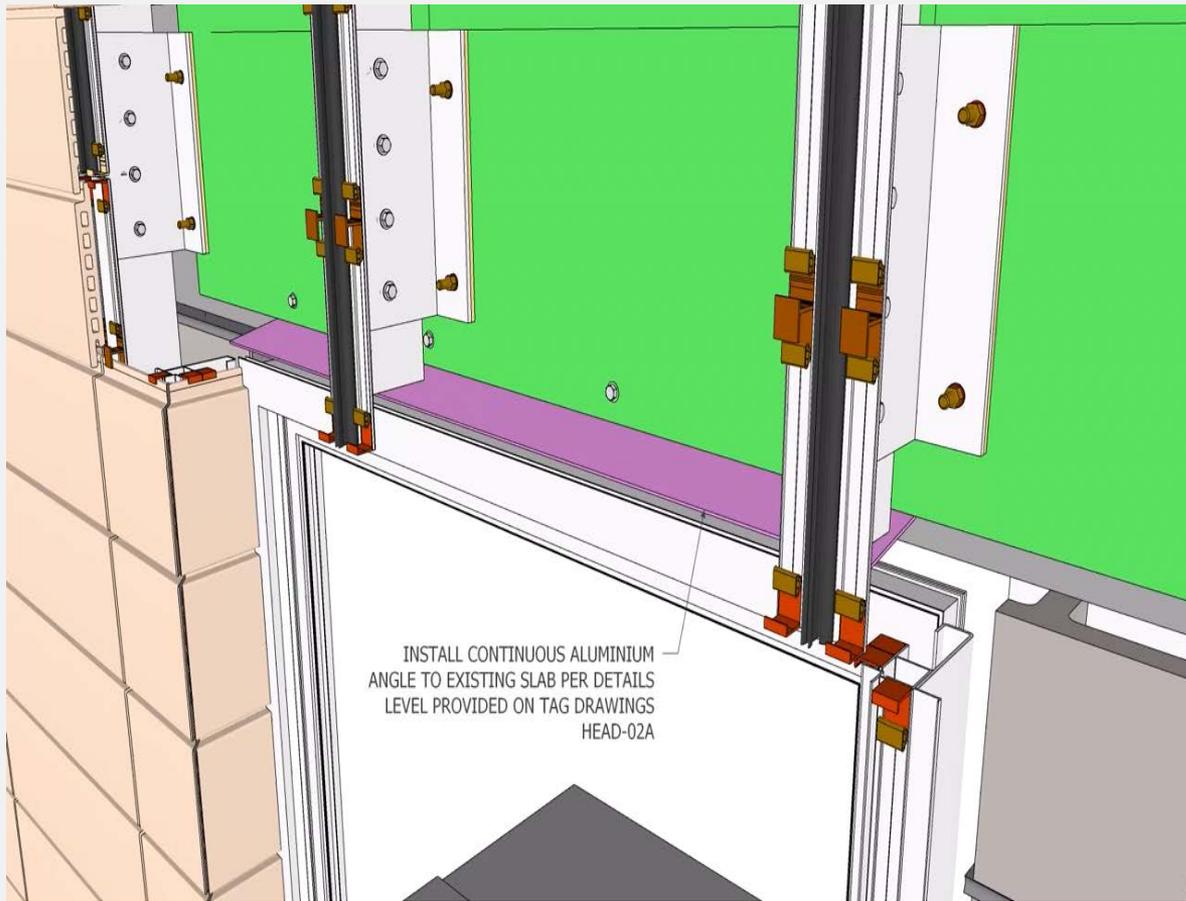
Installation

Main Support



Installation

Window Sill Assembly



Installation

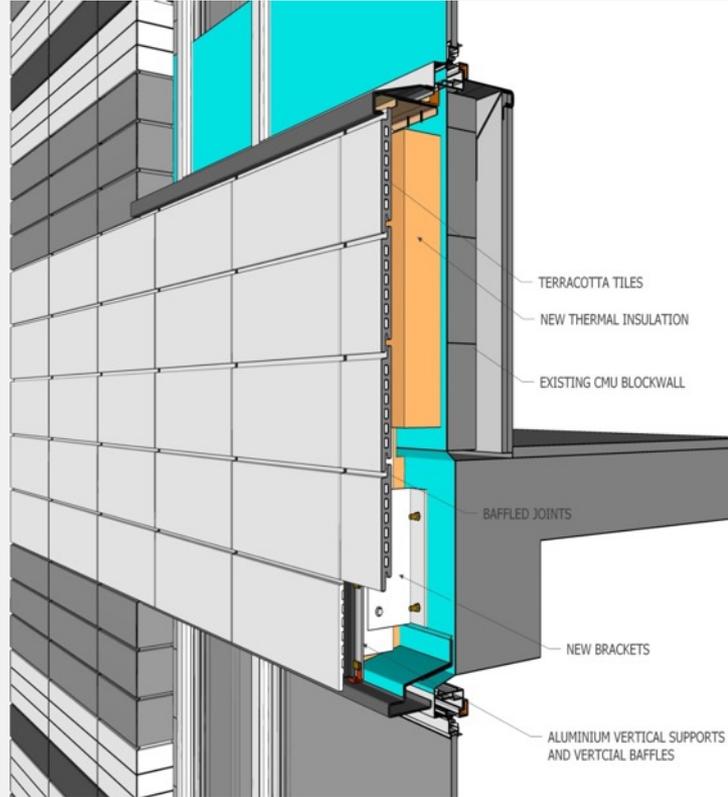
Window Head Trim Assembly



Installation

Tile

Finished Tile Installed



Finished Tile Installed





Project Completed

Questions?



Thank you